

Vol. 27 Parts 1—2.

Rubber Research Institute of Ceylon

First and Second Quarterly Circulars
for 1951



February, 1952

Rubber Research Institute of Ceylon

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NOTICES

DARTONFIELD ESTATE — VISITORS' DAY

THE services of technical officers are available to visitors on the second Wednesday in each month ; the estate superintendent is available every Wednesday. Visitors are requested to arrive on the estate not later than 9.30 a.m.

Visitors will be welcomed at the station on other days provided an appointment has been made in advance.

Dartonfield Estate is situated about $3\frac{1}{2}$ miles from the main Matugama-Agalawatta Road, the turn-off being near culvert No. 14/10. The distance from Colombo is approximately 47 miles.

PUBLICATIONS

Rubber Research Institute publications comprising Annual Reports, Quarterly Circulars and occasional Bulletins and Advisory Circulars are available without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of Rubber estates in Ceylon over 10 acres in extent. Forms of application for registration may be obtained from the Director. Extra copies of publications can be supplied to the Superintendents of large estates for the use of their assistants.

It will be appreciated if subscribers will return any back publications which are of no use to them.

ADVISORY CIRCULARS

The undernoted Circulars may be obtained on application at 25 cents per copy. Future issues in the series will be sent free of charge to estates registered or the receipt of our publications :—

- (1) Notes on budgrafting procedure (Revised June 1943).
- (4) Contour lining holing and filling, cutting of platforms, trenches and drains (Revised June 1943).
- (5) Straining box for latex (January 1940).
- (6) Notes on the care of budded trees of clone Tjirandji 1 with special reference to wind damage (September 1938).
- (8) Planting and after care of budded stumps and stumped buddings (Revised June 1943).
- (14) Rat control (September 1940).
- (17) Tapping young budded trees (Revised 1947) and 2 supplements.
- (19) Density of planting and thinning out (December 1942).
- (20) Recommended Planting material (1944) (Revised May 1944) and supplement.
- (21) The control of bark rot and canker, (April 1944).
- (23) Uniformity in the Nomenclature of clones and Clonal seedlings (December 1944).
- (24) Treatment of brown bast (December 1944).
- (25) Ground Covers (January 1945).
- (26) Clonal seed as planting material (July 1947).
- (27) Collection and planting of clonal seed (April 1949).
- (28) Oidium leaf disease (November 1950) superseding Circular No. 22.
- (30) Fertilisers for rubber (August 1951).
- (31) Root disease in replanted areas (October 1951) superseding Circular No. 10.
- (32) Crown budding for Oidium resistance (October 1951).

LEAF MILDEW OF RUBBER—A REVIEW

By

H. E. YOUNG

THE present enquiry was instigated by a recommendation made in the "Report of the Commission on the Rubber Industry of Ceylon" (1947) that, as oidium leaf disease constitutes a very grave menace to Ceylon's better rubber areas and the damage done by other diseases fades into complete insignificance in comparison "that a Mycologist be appointed to study the question of this disease as this matter is of paramount importance to Ceylon's Rubber Industry".

The Commission reported that at least 110,000 acres of Ceylon's rubber had reached an uneconomic condition due to oidium leaf disease. Rubber which was yielding 500 lbs. per acre was, due to this cause, now giving less than 200 lbs. and at high elevations was rapidly passing out of existence.

On the writer's appointment in 1949 to carry out the proposed studies a review of all previous relevant observations reported in regard to this disease was made and the present paper is published with the intention of recording in a collated and summarized form what appear to be the salient points of the previous work on the subject.

A bibliography of any references to *Oidium heveae* which were consulted and considered of any importance for the proposed investigations was made and for the convenience of those interested is appended to the present paper.

Occurrence and Geographical Distribution.

The occurrence of a leaf disease in *Hevea brasiliensis* in August 1918 was reported from an estate in the Malang region of Java by Arens (1918). It was shown to be a powdery mildew and was found to be present all over Java.

The symptoms reported were the loss of the shiny bronze colour of young leaves, which became dull and faded, accompanied by distortion of the ends and edges of the leaf blades. Shortly after this occurred the leaves fell. The petioles remained on the trees for some days subsequent to defoliation but eventually fell also. When more mature leaves were attacked they did not all fall as sometimes one or two of the three leaflets survived.

A white down consisting of the mycelium of the fungus and the conidia was common on the under surface of the leaves and was very conspicuous on the inflorescences of diseased trees. On older leaves and young shoots the fungus was seen to form small spots with a velvety appearance which however later became a powdery white. All stages between almost completely bare trees and very slightly affected ones were found.

The conidia or spores of the fungus were found at the ends of small erect conidiophores or bearers with only one or two conidia at the end of each conidiophore. The conidia were found to be barrel shaped and measured 28–42 microns by 14–23 microns. They were hyaline and some contained large vacuoles. Perithecia were not found.

It was suggested by Arens that spraying with Bordeaux mixture would be the only practicable control and that the selection and vegetative propagation of immune varieties should not be impossible. Arens also recommended that

seriously diseased trees should not be tapped and that they should be treated with a strong manure.

In 1921 Oidium on Hevea was reported in Uganda (Small 1921) where it then appeared in two localities and caused leaf fall and some twig die back. The fungus agreed in all characters with that described previously in Java.

The fungus was described and named *Oidium heveae* by Steinmann (1925) when he was describing the leaf diseases of *Hevea brasiliensis*.

At the end of February 1925 the disease appeared in the Kalutara district of Ceylon when it was identified and reported upon by Stoughton-Harris (1925) of the Rubber Research Scheme. The description of the fungus given is identical with that described by Arens (1918) and Steinmann (1925). In the same year (1925) a disease which occurred in widely scattered areas in Malaya was considered (Sharples 1926) as being the same as that described from Java and Ceylon. Some years later in 1929 *Oidium heveae* was identified in Indo China (Constantin) and in 1937 the disease was recorded from the Belgian Congo (1937).

Since this date no further spread except locally in the countries mentioned has been reported and it is noteworthy that this disease has as yet not been recorded in the South American region where Hevea is endemic.

Origin.

As this disease has never been recorded on Hevea in its native habitat and first appeared in Java it is evident that a fungus on some other plant must have adapted itself to this new host. Some powdery mildews are very particular as regards their hosts and particular strains have been shown to confine themselves to specific host plant. Although the fungi which cause powdery mildew on two host plants may be morphologically similar it could not be unusual if the fungus from one host species were unable to affect the other. It appeared to the early investigators that by some modification of its character the fungus now known as *Oidium heveae* must have already been present at least in Java on at least one other plant before it occurred on Hevea. Petch in Ceylon (1921) considered that the Hevea mildew must have spread from some allied species of flowering plant and mentions records in the tropics of mildews on *Euphorbia hirta*, *Euphorbia rothiana*, *Phyllanthus niruri*, *Phy. reticulatus*, and *Jatropha curcas* all of which are members of the order Euphorbiaceae to which Hevea belongs. The first three are common weeds and the fifth a common hedge plant. Petch's attempts to infect Hevea seedlings with the mildews of *Euphorbia hirta* and *Phyllanthus niruri* in Ceylon were unsuccessful.

Stoughton-Harris (1925) found that the mildew on *Euphorbia hirta* (pilulifera) in Ceylon was microscopically identical with *Oidium heveae*. Attempts made by him to inoculate *Hevea brasiliensis* with this fungus were also unsuccessful.

Young (1950) finally proved in Ceylon that the powdery mildews on *Hevea brasiliensis* and *Euphorbia pilulifera* were identical and readily transferable from one species to the other. It therefore appears that *Oidium heveae* was present in the East prior to the introduction of Hevea and that it probably spread from the weed *Euphorbia pilulifera* to its new host.

No comments regarding the origin of the disease geographically and its method of spread to other countries can be found in the literature excepting the records of its first appearance in the countries previously mentioned. As however *Euphorbia pilulifera* is distributed through these countries it appears probable that the parasite was present there before Hevea was introduced.

Nature of the Fungus.

The fungus is one of the Erysiphaceae a group of which no members have yet been recorded as growing successfully on artificial media. No resting spores have yet been found in the species under consideration.

Since the first report on the fungus by Arens (1918) and his original description a considerable amount of work has been carried out concerning its growth requirements and habits. The description of the fungus by Arens and the diagnosis later published by Steinmann (1925) are still unaltered. Steinmann's description of *Oidium heveae* n. sp was published without a latin diagnosis and is as follows :

" The conidia (only one or occasionally two on a conidiophore) are ellipsoid to barrel shaped, hyaline, and contain a few large nuclei. They measure 28—42x14—23 μ (mostly 35x17 μ)..... The perithecial stage is unknown..... The mycelium develops on the surface of the infected plant organs, whence it obtains the necessary food supplies by means of haustoria....."

In Java Bally (1927) describes longer chains of conidia (upto five) than those reported by Steinmann (1925) and Stoughton-Harris (1925) and the spore measurements are given as 25—30x14—17 μ as compared with 28—42x12—23 μ found by Arens, Steinmann and Stoughton-Harris. In Uganda Small (1923) reported that the fungus was similar to that described from the Dutch East Indies.

In Ceylon Gadd (1926) recorded the measurements as follows conidiophores 46x6.8 μ conidia 30—33x12—16 μ with not more than three conidia on each conidiophore whilst Bally (1927) in the Dutch East Indies considered the species there identical with the Ceylon species but his conidia measured 25—30x14—17 μ Sharples (1926) in Malaya does not give spore measurements but considers the disease the same as that occurring in Ceylon and the Dutch East Indies.

The following spore measurements have therefore been recorded in the literature.

Arens	(1918)	28—42x14—23	microns
Stoughton-Harris	(1925)	28—42x14—23	"
Steinmann	(1925)	28—42x14—23	"
Bally	(1927)	25—30x14—17	"
Gadd	(1926)	30—33x12—16	"

The number of conidia reported in a chain varies from one to five or more and does not appear in any way to be a stable character.

Life History.

A comprehensive paper concerning *Oidium heveae* was published by Bally (1927) where he reviewed all the work up to that time and recorded the results of his own investigations. The general spread and increasing damage caused by the disease is described and its similarities with other fungi of the same group noted.

No investigators have yet recorded success in cultivating any kind of powdery mildew fungus on an artificial medium but it is possible to germinate the conidia after which they die and a number of people have observed the conidia germinating on leaf surfaces and experimental infections with other mildews and their hosts have mostly been successful. Artificial infection of *Hevea brasiliensis* was found to be difficult and few investigators were able to carry out this process.

When a conidium of *Oidium heveae* germinates on a leaf the young mycelial thread grows out and spreads over the leaf surface forming the well known white fluff. Small pad like growths called appressoria are formed on the leaf surface by the fungus. These appressoria later develop into haustoria or sucking organs which penetrate the leaf cuticle and act as roots for the absorption of food from the leaf. In the case of *Oidium heveae* there is no record of the presence of intercellular hyphae and described by Smith (e.g. Zimmerman 1925) for *Phyllacteria suffulta*.

After a very short time mycelia are produced which grow away from the leaf surface. These are the conidiophores on which are developed the conidia which are the only recorded means of propagation. The conidia when mature break off the conidiophores and are distributed by the wind. If they are deposited on a suitable Hevea leaf under the right conditions they germinate and again go through this cycle.

Bally (1927) considered several possibilities concerning the atmospheric conditions necessary for germination and growth of spores of *Oidium heveae*.

I a	The conidia germinate well in humid weather.
b	" " dry "
II a	The mycelium develops well in humid "
b	" " dry "
III a	The conidia are mainly produced in humid "
b	" " " " dry "

and considered that the aspects of infection would be completely different when the various possibilities are combined. He considered the settling of these possibilities of prime importance in connexion with control measures.

The Erysiphaceae to which group *Oidium heveae* belongs are in general insensitive to the dryness of the atmosphere and it was shown by Salmon that the young germinating fungi do not require much water. It was also shown that an atmospheric saturation had an unfavourable influence on the development of powdery mildews (Vavilov). In the case of apple mildew it has often been shown that hot dry weather is especially favourable to its occurrence. On the other hand there is no lack of conflicting reports some presuming that foggy sunless days are favourable for infection and others that in hot dry weather mildew should occur in lesser degree. With *Oidium heveae* the matter was finally settled by S'Jacob (1930) who showed that the conidia germinate most readily in a damp atmosphere without contact with free water. It was shown by Young (1950) that the conidia of the parasite are unable to infect the leaf in the presence of free water. The spores germinate on a wet surface but grow away from it. On a dry surface they grow towards it and are then able to adhere and cause infection.

Two questions which were continually cropping up were in connexion with the sudden disappearance of the fungus at the end of the season and the manner in which the fungus lived between seasons.

The first question was partly answered by the fact, observed quite early in the history of *Oidium heveae*, that mature Hevea leaves do not form a favourable substratum for *Oidium*. Bally (1927) observed that the thicker walls of the outer cells of the older leaves are probably not so easily penetrated by the haustria. S'Jacob (1930) found that the thickness of the leaf cuticle increases with the leaf age and considered it improbable that the fungus was able to penetrate the thicker cuticle of the older leaf. This fact alone however did not explain the disappearance of the fungi because actually there is always present in a plantation some young immature leaves. In grape mildew (*Oidium*

tuckeri) De Bary described a parasite which lived on the mildew fungus. This is *Ciccinobolus cesatii* which appears at the end of summer and destroys the last fructifications of the Oidium. In the tropics fungi parasitic on Oidium have been reported also. A Ciccinobolus parasitic on the Oidium which infects *Manihot dichotoma* is described by Zimmerman and in the case of Hevea a Ciccinobolus attacking *Oidium heveae* is described by Gadd (1926). This has been found to be almost universally present on older Oidium lesions in Ceylon and can be considered an important means of checking the fungus.

In regard to the manner in which the fungus lives through the wet season several possibilities have been suggested. The more important of these are

1. The main fructifications (perithicia) are found in which the ascospores develop (Bally 1927) and over wintering in this stage is possible.
2. The mycelium of *Oidium heveae* lies dormant in unfavourable weather (Bally 1927).
3. *Oidium heveae* is a type which can live on other plants.
4. The fungus lives in the dormant buds (Bally 1927).

In regard to the first possibility analogies may be drawn with other powdery mildews. In this group of fungi a characteristic is that under certain circumstances they are able to form another type of fruiting body, the peritheciun, which is a convex dark body. These are known in many cases and in others it took many years before they were found. The best known example is the powdery mildew of grapes. This disease has been known in Europe since 1845 under the name *Oidium tuckeri*. The perithecia were first found in 1892. The same thing happened with the oak oidium and gooseberry oidium.

Search for these resistance spore bodies in the case of *Oidium heveae* has been so far unsuccessful.

In the case of the second possibility there were two main lines of investigation. The first being that the fungus penetrates the leaf and lies dormant there until suitable weather conditions occur for further growth and formation of spores. This was known already for the family Phyllactinia and secondly that the mycelium remains during unfavourable growth periods on the branches or under the bud scales.

Bobiloff (1928) in Java noted the occurrence of living Oidium mycelium around old mildew spots on Hevea leaves (verified by Young (1950)) and considered the possibility that the fungus hibernates in the leaf in this state and found oidium on leaves with old lesions in spite of the heavy rains of the West monsoon. This investigator also found young infected leaves in the middle of the West monsoon making it possible that the mildew after the next refoliation originates from there. In the next year (1929) the same author reported his observation wherein he traced oidium from refoliation where the attack was general right through the year on succeeding young shoots up to the next refoliation and solved the problem of hibernation by showing there was none. This point was later checked in Ceylon by Hansford (1948) who obtained the same results, and again by Young (1950). In regard to hibernation in the bud scales as was suggested by Bally (1927), Beeley (1930) reported the presence of mycelium in a newly opening terminal buds. However as these buds take some days to open this mycelium if that of *Oidium heveae* may have resulted from a spore or spores which recently found its way into the opened bud parts. Again in 1939 Beeley considers the fact that infection appeared within 48 hours of the onset of dull weather supports the view that *O. heveae* hibernates in the buds and that as these open the mycelium favoured by dull cool humid conditions produces an early crop of conidia. This reasoning however owing to further findings is not necessarily valid and probably incorrect, as it has been shown by Young (1950)

that spores of the parasite are able to germinate within 1½ hours, Hansford (1948) also considered this theory, which was supported by Beeley, to be incorrect as the fungus would be able to grow along developing stems and leaves and cover them every year with its colonies. No trace of such growth was found, the first signs of infection being when the young shoots are about an inch long. At a later stage the fungus is able to attack and kill the flower stems bearing them. It is evident therefore that the fungus is not necessarily unable to attack young stem tissue, and its absence from the developing branches would appear to indicate that it is not present in the buds.

When the same writer (Hansford 1948) bagged large branches in two experiments all the leaves and shoots which developed inside were free from disease, those outside on the same tree developed the disease. The same author considered it sufficiently established that the annual infection epidemic commences from outside the individual tree infected and is air borne. This view corresponds to the already proved facts mentioned by Bobiloff (1928).

The third possibility envisaging the existence of an alternate host plant was demonstrated as being a fact by Young (1950) where it was shown that *Oidium heveae* was present throughout the year on *Euphorbia pilulifera* and that the disease could be caused by transfer of the fungus from one host to the other. In this respect it is noteworthy that the disease was first reported in Ceylon at the changeover from clean cultivation of rubber fields to the cover crop system wherein weeds of course are able to grow. It therefore appears probable that the green cover system allowed the natural host of the fungus to grow and so afforded the opportunity for the disease to attack rubber.

Several other facts may be taken as supporting evidence. In one case the cover crops on an estate were inadvertently burned about the wintering period and no infection appeared in the burnt fields.

In another inorganic nitrogen was applied as manure to part of an estate about the wintering period and burnt off the ground cover due to dry weather, and no oidium attack was noted in the manured fields as compared with normal attack in the unmanured fields.

Damage caused by Oidium.

Arens (1918) was unable because of the recent appearance of the disease to estimate the damage it was likely to cause but considered that owing to the serious plant diseases caused by similar fungi this one should be kept under close observation. His fears have proved justified.

Each year the reports of this disease laid gradually increased emphasis on the damage caused by it until Small (1929) in Uganda first mentions that the disease is estimated to cause a considerable reduction in latex yields and in one case had led to a twig dieback. In the same year Ultee (1929) in Java reported some estates as loosing leaves 2—3 time in the one season. Bally in his important paper on the disease in 1927 remarks that practical planters at that time considered the disease more serious than did the scientists and Bally summarised the then existent state of affairs and considered that the situation was best described by Stahel in his monograph on South American leaf disease (*Dohidella ulei*) (1917).

In brief Stahel considers that a branch which is forced to produce new leaves several times in succession uses up its food reserves which are mainly present in the form of starch. As soon as new carbohydrates can be formed as a result of leaf assimilation, the food reserves in the branches and stems are again built up. If however this replenishment does not occur the reserves become exhausted, Stahel (1917) proved this by checking how much starch was present in a

tree at various heights and found that a tree after having wintered twice successively had exhausted the starch reserves of its branches and of its trunk above three metres. After a repeated dropping of the leaves however the depletion of carbohydrate reserves was apt to go so far that first the branches and then the trunk dies. These results were also checked by the writer (Young) in the case of *Oidium heveae* in Ceylon and similar observations were recorded.

Bally checked these observations in the case of *Oidium heveae* leaf fall in Java (1927) and found that a similar process occurred although to not such a large extent due to the fact that only one leaf fall had been experienced at the time of his examination. Four main conclusions were drawn by this writer from his studies.

(1) The mycelium of oidium is capable of causing young leaves to drop. Older leaves are not susceptible to infection. The mycelium is only growing at the surface and forms sucking organs (haustoria), which penetrate into the outermost epidermal cells.

(2) By new formations of leaves, the food supplies for development are drawn from the starch reserves of the trees, a repeated development of leaves therefore results in a reduction of these reserves.

(3) As has been proved by Stahel, branches may die back as a result of the exhaustion of the starch reserves, and, in the branches suffering die back, secondary fungi may occur and complete the work of destruction started by Oidium.

In Ceylon dieback due to Oidium attack depleting food reserves has now become common in some areas. The dead branches are frequently invaded by the fungus *Botryodiplodia theobromae* which often causes further dieback and even death of the trees.

(4) In cases where mildew attacks half developed leaves it is not usual for the leaves to fall as is the case with younger leaves, yet such an attack as pointed out by Bobilioff (1928) is of course harmful to the trees. The surface of the leaves which are responsible for carbon assimilation is degenerated so that they cannot function normally.

Results of an enquiry into prevalence of mildew on rubber estates in E. Java (Reydon 1927) showed that dieback of branches (and decreased yield) was ascribed to mildew by a large proportion of the planters.

In one country only, Indo China, has damage due to this disease escaped much mention since first recorded. It was found there in 1929 and was not commented on again until 1949.

The effect on yield has been shown to be due to a large extent to decreased girth increment and consequent poor bark renewal. This is a cumulative effect and becomes more severe with each consecutive attack.

Estimates of reduced yield due to mildew attack have been made in many cases Leefmans (1928) in Java estimated a drop of 10% in crop for the year following one attack.

Aments (1930) found a drop in yield of 22% over an eleven month tapping period whilst sulphur dusted plots did not show this loss. Other authors gave similar figures with a further decrease in yield in the second year following a succeeding attack.

In Ceylon Murray (1931) obtained a 16% increase in yield in a mildew affected area in the dusted plots in the first dusting season and a 75% greater increase in the next season. There was also a 39% increase in renewed bark in the protected (sulphur dusted) plots over the undusted plots. This effect was carried on in the next season when no mildew appeared.

Schweitzer (1936) showed by hand plucking that a defoliation after refoliation always gives a considerable reduction in yield, a loss of 11—34% of annual production being recorded when 50% of leaves are removed. There was shown to be a strong correlation between leaf area and latex yield. After a defoliation the new leaves produced are smaller and with continued defoliations branch dieback occurs.

Susceptibility to Mildew attack.

The question was early asked, if every plant is susceptible in the same degree to infection ? and it soon became clear that trees which refoliated very early in the wintering period did not get much attack because there was insufficient fungus inoculum available then to cause a heavy attack. As the season advances however it became obvious that the mildew population built up, causing increased damage to the later refoliating trees.

Only those trees which form new leaf in the period of most severe attack and of which the newly formed leaves and inflorescences are not attacked can be considered immune (Bally 1927).

The characteristics of trees as regards wintering were early grouped by Bobilioff (1929) as follows :—

- (1) **Early winterers.** Slight attack of young leaves, no or little leaf drop. Later, on the full grown leaf, little or nothing to be seen of that attack.
- (2) **Winterers during mildew attack.** Leaf fall, newly formed leaves are little attacked later on.
- (3) **Later winterers.** Leaves do not fall, while half grown leaves are severely attacked.

Because however various stages of the leaf occur on the one tree it is not always possible to draw a sharp line between the above three kinds of trees.

A search for immune trees was carried out in Indonesia and Ceylon. In Indonesia a selection of trees with possible mildew resistant characters was examined by Maas (Cramer 1934) and of these one tree was established as a clone called LCB. 870. This clone proved to be mildew resistant but not high yielding. No resistant trees were found in Ceylon.

Crown Budding for Resistance

Records of experiments in Java with LCB. 870 as crown buddings commenced in 1928 were lost during the Japanese occupation until recently found. In the meantime budwood of this clone was imported into Ceylon and established in a mildew resistance trial along with other possible varieties by the Rubber Research Scheme (Ceylon). Clone LCB. 870 proved itself definitely resistant (Young 1949) and the reason for its resistance was shown by the same author (1950) to be due to the rapid development of the cuticle as compared with other clones. This allows of only a short period during leaf growth during which infection can occur and does not allow of sufficient time for much damage to occur even when infection does take place. The flowers and flower shoots of this clone are not resistant however.

As this clone is comparatively low yielding it is unsatisfactory as an estate tree and experiments have been commenced using the resistant crown of LCB. 870 budded onto high yielding tapping panels. In the meantime (private communication) the crown budded trees established in Java in 1928 are now being tested for yield etc. and a recent private communication indicates that

an LCB. 870 crown depresses the yield of the tapping panel unless the bud union is about 150 cms. above the tapping cut when no bad effect occurs.

Breeding for Resistance.

Another possibility is in breeding for resistance and work in this connexion has been commenced in Ceylon by producing seedlings obtained by the cross pollination of high yielding clones and the resistant clone LCB. 870 in order to obtain high yield combined with resistance. Sulphur dusting to protect the flowers is essential.

Spread of disease.

The study of the spread of mildew amongst Hevea trees was thoroughly gone into by Bobiloff (1929) in a large scale series of experiments which resulted in the following conclusions.

- (1) The fungus from one leaf passes to another i.e. it travels only short distances in one stage.
- (2) The fungus spot spreads constantly until the maximum under the given condition is reached.
- (3) After the maximum is reached, a decrease in size of the fungus spot occurs due to the dying off of conidia.
- (4) The mildew on any leaf is in a virulent stage and full of conidia for about five weeks.
- (5) The quantity of the fungus in any area at any time is dependent on the quantity of susceptible material available, as the young Hevea leaves are the most suitable medium for the fungus most mildew is possible immediately after wintering.

Bobiloff clearly proved that it is irony to speak of a sudden mildew attack but that we must talk of the "optimal point" which appears in a different way under different conditions. When the weather is favourable the leaves fall from the trees when the optimal point is reached, in the opposite case when the weather is unfavourable, a slight leaf drop or no leaf drop at all was observed.

The way of spread of infection in any one estate was also traced first by Bobiloff (1929) who showed that in any one area the infection does not come from outside but from inside and that when new shoots appear on a tree next to an infected one the former gets infected. That is that infection is from tree to tree over short distances and from leaf to leaf in any one tree. This spread of course was also shown to depend on the direction of the air currents which carried the spores. This was verified by Young (1950) who also demonstrated the short life of the spores in sunlight (about $1\frac{1}{2}$ minutes).

Control of Oidium by Cultural Practices.

The control of Oidium other than by natural resistance also received early attention. Attempts to influence the disease by manuring were made quite early but it was soon shown that the effect of manuring some months before wintering tended to cause delayed defoliation and refoliation resulting in more severe mildew damage.

Among other cultural practices tried were those of Bobiloff (1928) who showed that the removal of late shoots just prior to wintering exerted some control by removing much of the source of inoculum,

Control by Chemicals.

Control by chemicals was attempted early in the progress of the disease and Bally (1926) in Java first used Bordeaux mixture without much success and also lime sulphur sprays. In 1927 Gandrup and S'Jacob experimented with Bordeaux mixture, lime sulphur " (sulfinate)" and a sulphur dust suspension in water and obtained good results with the lime sulphur and sulphur sprays.

In 1928 Bobilioff suggested aeroplane dusting with sulphur dust.

In 1929 a number of sulphur dusting machines were tried out in Java including the Platz a German duster, the Sulfia motor duster, the Bjorkland duster and the Sulzer duster all of which produced good results. In the same year (1929) aeroplane dusting with sulphur dust gave good results (de Vries).

In 1930 Murray in Ceylon with a Bjorkland duster using 10½ lbs. sulphur per acre obtained full control of Oidium and the area controlled showed an increased yield of 16% the first year and 75% the following year and a 39% increase in renewed bark in the first year. The Noidium and Drake & Fletcher apparatus were also used satisfactorily in Ceylon in that year.

Wet spraying was abandoned because of mechanical difficulties and costs, although lime sulphur gives more satisfactory control if it can be applied.

Since that time it has been found (Young 1950) that adequate control may be obtained if sulphur dusting is carried out at the rate of 10—12 lbs. per acre per dusting round, the dustings being done at 7—10 day intervals until refoliation is complete. Dusting must commence before leaf renewal commences i.e. on bud break after defoliation as otherwise it is too late to prevent most of the trouble (Young 1950).

Control with lime sulphur spraying is possible in small trees but cannot be carried out in mature trees owing to the necessity for roading estates elaborately for access with the large spraying machinery necessary.

Dusting with machines which have twin bend outlet ducts which produce a turbulent cloud of dust has proved satisfactory. Of these machines two types are at present available and have been used in Ceylon, the 'Whirlwind' and the new type 'Noidium' dusters. The latter is the most satisfactory owing to its lighter weight which is a very important factor where the machine has to be carried by labour.

The type of sulphur used is of importance particularly in regard to fineness. The standard U.S.A. 325 mesh or British 300 mesh specification proving satisfactory in dusting properties. Coarser grades are disadvantageous. Purity according to these specifications is also satisfactory.

A type of sulphur known as 'activated sulphur' which depends on its colour due to incorporated carbon for quick activation by heat absorption has also given good results at half the dosage rate of normal sulphur.

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CROWN BUDDING FOR OIDIUM RESISTANCE

By

H. E. YOUNG

Crown budding with the object of producing a rubber tree with high yield and a disease resistant crown was carried out first in Java in 1928. In this process it is usual to produce a tree of three parts i.e. a root stock budded with a high yielding clone and this again budded with the resistant clone. This is necessary because the high latex yielding material so far developed has not proved to be resistant to leaf disease. In the early years of crown budding in Java Clone LCB. 870 had been selected for resistance to *Oidium heveae* but had shown itself to be a mediocre yielder of latex. The crown budings in Java proved successful and the records of the tappings have just been found again after the Japanese occupation and the material is being further tested.

A summary of the conclusions now drawn from the early tests is as follows :

1. "The yield capacity of the crown of LCB. 870 was low being only 63% of the yield of comparable unbudded seedlings at the same height.

2. The LCB. 870 crowns had a marked depressing influence on the yield of the seedling stock, this yield being only 75% of that of comparable unbudded seedlings at the same height.

3. This yield depressing influence appeared to extend itself to at least 100 cms. from the union. However at 150 cms. below the union the yield of the stock was exactly the same as that of the unbudded seedlings at the same height. So it appears that the depressing influence extends to somewhere between 100 and 150 cms. below the union. As the experiment was stopped before its time it is impossible to say as yet at what exact distance from the union the adverse effect of the LCB. 870 crown becomes negligible.

4. To be safe, the top budding should be therefore done at a height of 250 cms. so as to obtain an unaffected tapping panel of at least 100 cms. from ground level.

Full particulars of this will be given in "De Bergcultures". (Ir. J. S. Vollema, private communication).

From the above it will be seen that at present crown budding should be carried out at a height of eight feet in order that the yield of the tapping panel should be unaffected.

Crown budding using the three part tree technique was carried out by the Rubber Research Institute of Ceylon in 1935 but unfortunately clone LCB. 870 was not then available here. Further trials have been put out in post war years but are not yet in tapping.

The crown budding method has also since been adopted as a means of obviating South American Leaf Cast disease as caused by *Dothidella ulei* in South America.

Method of Budding

Ideally the budded plant or clonal seedling which is to be budded should be at that stage of growth at which brown wood has developed a little above the point to be crown budded.

The operation is carried out as follows :—

Either clonal seedlings or budded plants may be used. In the case of the latter a three part tree, stock, panel and top results. The budding is carried out as in normal stump budding except that it is done at a greater height and in the field (see Advisory Circular No. 1 notes on Budgrafting Procedure—June 1943).

Budded stumps or clonal seedlings are most suitable for crown budding by the time that brown bark has developed to the necessary height.

This height should not be less than eight feet as the budding should be done there to obviate any reduction in yield.

Older and larger trees are somewhat unsatisfactory owing to the large scar, which takes some time to heal, which occurs when the top is cut off.

The budding is carried out of course when the field plants peel satisfactorily. It can be done from a box or short ladder on the ground. The operation is carried out otherwise in the normal way.

After successful examination of the buds the bud patch should be covered with one or two leaves to prevent scorching and drying out.

When the bud has successfully taken, the top of the tree is cut off about six inches above the bud.

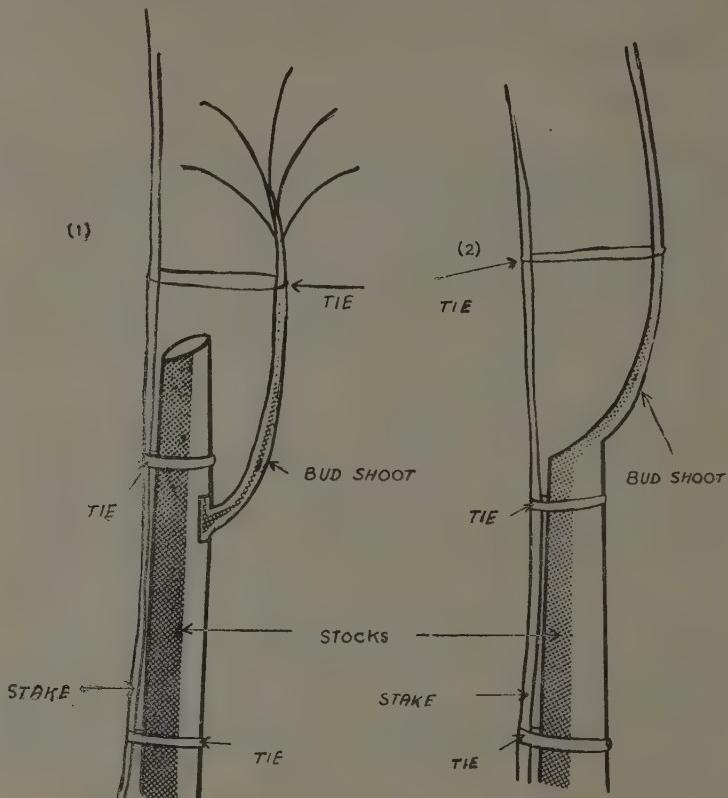
Several inspections are then required within the next few weeks during which all the panel shoots are carefully trimmed off to ensure that only the LCB. 870 bud grows.

When the LCB. 870 shoot is in its early green growth it, due to the exposed site, is very susceptible to breaking off by wind. To prevent this a stake is tied to the stem of the tree with coir rope. This stake should stand up above the stump for about 1½—2 feet. The bud shoot is secured to this loosely by another tie of cord.

The stake and shoot ties need occasional examination for tightening etc. As soon as brown bark develops for 3—6 ins. on the shoot the snag must be cut off with a slanting cut close to the junction of the bud shoot and stem. This closeness is essential for quick healing. The scar should be painted with a preventive wound dressing, such as Cargillineum, while freshly cut.

It is advisable to leave the stake support on the tree until the wound has healed which should have occurred in about 8 months with trees of the size mentioned. All stakes may then be dispensed with and the trees allowed to develop normally. A rough sketch of the tying procedure is appended.

Diagrammatic Representation of Support for Crown Budded Shoot



Budwood of LCB. 870

Budwood of this clone is being multiplied by the Rubber Research Institute for distribution purposes and considerable quantities have already been disposed of. It may also be obtained from the Institute's clone museum on Kepitigalla Group Ankumbura. The Superintendent of Kepitigalla Group has permission to dispose of this budwood as available.

Interests considering crown budding for Oidium resistance should obtain budwood for multiplication purposes for their own requirements.

Indications for Crown Budding

In badly mildew attacked areas i.e. at the higher elevations of rubber planting districts where yields have been lowered below 4-500 lbs. per acre due to mildew attack, replantings and new plantings should be crown budded to insure an economic yield. In the low country in areas where *Oidium heveae* does relatively little damage crown budding with LCB. 870 should also be carried out where oidium damage normally occurs.

ROOT DISEASE IN REPLANTED AREAS

By

H. E. YOUNG

Incidence of Disease:

When replanting of seedling rubber land was undertaken in Ceylon it was recognised that some of the young plants would possibly become affected by root disease contracted from centres of infection present in the original stand. It is now a matter of general experience and observation that, in addition to the occurrence of such cases, root disease may and does occur in areas thought to be free of infection as judged by the history and appearance of the old stand. Examination of the root systems of apparently healthy uprooted old trees in a clearing which is being felled has shown that some of the trees are often infected.

Where root disease occurs in replants every case investigated has shown that the fungus almost invariably must have been present before the old trees were removed, but was apparently not doing sufficient damage to produce visible above ground symptoms of its presence. In an infrequent case the trouble has been transferred to the field from an infected nursery. In some cases some roots on the old trees are found to be dead due to root fungi, with no above ground symptoms. In others the fungus is merely existing on the bark of the roots in a state of subdued parasitism. When such an infected tree is felled and its roots are left in the ground the balance between fungus and host tree is upset and the fungus assumes the ascendancy and grows actively along the dying and newly dead roots. If a young live root contacts this infected wood it rapidly becomes infected also with resultant death of the young plant.

In view of the unpredictability of the extent to which infection will occur in any particular area it is difficult to decide in advance whether the adoption of special precautionary measures when clearing the land will prove economically sound. The suggestion made by the Research Institute at present is that all the larger lateral roots should be removed when land is replanted in localities in which Fomes is known to have caused widespread damage. In any case the stumps of uprooted trees should be examined at uprooting for the presence of infection. When an infected tree is found full eradication measures should be undertaken. In all areas known to be infected the lateral roots should of course be removed and old disease patches thoroughly dug over with a view to the removal of old roots as completely as possible. Special attention should be given to the margins of the patches where the fungus is always most active. The presence of rotting timber on the ground surface is not considered to have any effect on the incidence of root disease except in an already infected patch in which case it may prove a source of food supply for the fungus and enable it to persist and be a danger. Burning of surface logs is otherwise only considered necessary in areas where damage to adjacent coconut estates may be caused by the breeding of coconut beetles in the rotting logs.

Poisoning of old stands.

The practice of poisoning old rubber and leaving it to stand and rot, and replanting between the poisoned trees is becoming a fairly common procedure. From the point of view of root disease this cannot be other than a dangerous

project. The tree poisons used such as sodium arsenite have no effect on any parasitic fungi which may be on the roots of the poisoned trees. If these fungi are present and the tree killed, the fungus can grow vigorously and spread out along the lateral roots where it is bound to come into contact with the new roots of some young plants sooner or later with unfortunate results. Poisoning is carried out on the score of economy but this is liable to prove false and a prelude to excessive disease control expenditure. In any case the uprooting of old rubber mechanically by such implements as the 'monkey' grubber has proved economical. Present costs at the Rubber Research Institute amount to 42 cents per tree. By this method of uprooting, the large laterals are also pulled out of the ground with the tree and in addition can be inspected for presence of disease and precautions taken where necessary. If no sale can be found for the timber it can be burned or left to rot quite safely on uninfected ground.

A practice of cutting off the old tree and poisoning the stumps to prevent suckering is sometimes resorted to. The argument against this is the same as with ordinary poisoning only this method involves the additional expense of cutting off the tree. One monkey grubber at Rs. 950/- operated by four labourers can on the average completely uproot about twenty six trees per day.

Causative fungi

There are three main fungi which attack the roots of living rubber trees in Ceylon. In order of importance they are:

Fomes lignosus.
Fomes noxius (Brown root disease)
Poria hypobrunnea.

Detection of Disease

When the roots of a plant are attacked by a parasitic organism the conducting tissues are killed. The roots are no longer able to act as channels along which water may pass to the stems, branches and leaves, and these are therefore starved of water. The first symptom is a wilting of the leaves accompanied by lack of lustre and slight discolouration. Later the leaves fall, the twigs die back and the whole plant dies. These symptoms are similar whichever fungus is concerned, and it is therefore impossible to identify the disease without inspecting the roots.

When symptoms of this nature are observed in the field the first step is to examine the leaves and stems carefully for any evidence of such trouble as Pink disease, Phytophthora infection or lightning damage. If there is no actual stem disease the trouble is probably in the roots and these must be carefully exposed and examined. The appearance of the above three fungi on the root is described below under the appropriate headings.

Fomes lignosus

Appearances of Roots : The fungus will be immediately evident as a mycelium consisting of whitish or yellowish or pinkish strands running over the surface of the roots and adhering firmly to the bark. When young the mycelium consist of fine white silky threads, but later these coalesce into coarser discoloured strands which are called "rhizomorphs" on account of their resemblance to small roots. Certain other wood-rotting fungi of the class to which Fomes belongs, produce similar rhizomorphs and these may be found growing over the surface of rubber roots without causing any disease. It is not always easy to identify the fungus without examining fructifications but, in general, Fomes may be distinguished by the fact that the rhizomorphs

adhere closely to the bark and are not easily rubbed off. Moreover, they are never dead white but always discoloured.

The cortex and wood of an infected root are permeated by fine mycelia threads which feed on the cells, thus causing them to break down and the root to rot. The rotted wood is soft and sometimes wet.

Fructification : Fructifications of *Fomes lignosus* may be formed wherever an infected root or stump comes to the surface of the ground. The fructification is produced as a bracket growing out horizontally from the diseased wood. When fresh the upper surface is a rich, red brown in colour with a lighter coloured margin, whilst the underside, which consists of a large number of minute pores, is orange in colour. As the bracket becomes older and dried up, the upper surface fades to a pale orange colour, while the lower surface becomes dark brown. On breaking the fructification in two, the upper layer will show white and fibrous and the lower red-brown.

Fomes noxius (Brown Root Disease)

Appearance of Roots: The roots, especially the tap root, are encrusted with a mass of sand, earth and small stones to a thickness of three or four millimetres. This mass is cemented to the root by the mycelium of the fungus, which consists of tawny brown threads collected here and there into small sheets or nodules. In the early stages the predominating colour is brown, hence the name Brown Root Disease, but as it grows older the fungus forms a black brittle, continuous covering. In all stages, however, the disease is distinguished by the encrusting mass of earth and stones which cannot readily be washed away.

If the outer coat is scraped away the cortex of the root is found to be decayed, and usually coloured brown or brown mottled with small white patches. The wood is soft, usually dry, and permeated by fine brown lines.

Fructification : The fructification is rarely formed and need not be described.

Poria hypobrunnea

Appearance of Roots: The fungus forms stout red strands on the surface of the root, but these will only be seen if the disease is detected at an early stage. Later the strands turn black and form an irregular skin which is whitish internally. Like *Fomes noxious* the root is often encrusted with earth and stones, though not to so great an extent. In an advanced stage the diseased wood is soft and friable and permeated with reddish lines.

Fructification : The fructification is sometimes formed at the collar of the young plant. It is a flat plate closely applied to the surface of the root or stem, and at the stage usually found is of a slate-mauve colour.

Control Measures

When a diseased plant is discovered the first step is to disclose the source of infection. This is done by following the roots of the affected plant outwards in all directions from the planting hole until the guilty stump or root is found. This must then be removed and burned and all timber bearing the typical mycelium, whether old roots or young rubber roots, treated likewise. In this exploratory work it may be found that one or more roots of an adjacent rubber tree have also contracted the disease although the foliage is still quite healthy. Such roots should be amputated in healthy tissue and the cut ends tarred, or if necessary the whole plant removed. For additional security a trench 2 feet deep should be dug around the infected area and kept clear until infection is eliminated.

Diseased material must be burned on the site and not taken away as firewood or to be burned elsewhere and all soil removed must be put on the site not outside it as it may spread the disease further.

The essence of successful control is to eradicate the fungus completely in the early years of the clearing, and the treatment outlined above, although somewhat expensive, will pay for itself handsomely by preventing the occurrence of the large disease complexes which are unfortunately to be found on many old estates at the present time.

The treated area should be kept clear of creeping cover crop for about two years, but should be planted thickly with *Crotalaria anagyroides*. This plant is also susceptible to attack by root diseases and the presence of any diseased bushes will indicate the existence of a piece of infected wood which was overlooked in the original exploration. The bushes should therefore be inspected from time to time and any dead or sickly plant pulled up for examination of the roots. If these show the typical symptoms of any of the diseases previously described the source of infection must be traced and removed. These *Crotalaria* plants must only be lopped very lightly or they will die back on account of lopping and lose their value as indicators.

Any vacancy resulting from root disease should be supplied with a budded stump without delay, provided the clearing is not older than two years from the time of budding. Stumped buddings may be used as supplies for a further year, but thereafter it is uneconomic to supply vacancies unless they occur in a group.

Root Inspection

In a clearing where root disease is prevalent it is recommended that the above measures be supplemented by periodical examination of the root system of each individual plant, the object being to disclose and remove the sources of infection with the least possible delay and thereby to save young plants which would otherwise be killed. The method is to excavate the hole of each young plant until the tap root is exposed to a depth of about six inches and the upper laterals for a distance of about twelve inches from the stem. The work should be carried out with a pointed wooden tool so as to damage the roots as little as possible. The plants thus examined can be divided into two categories :—

(1) Those on which there is no trace of *Fomes* mycelium. In such cases the earth is carefully replaced and packed round the roots which have been exposed, and the tree is given a mark to signify "examined and found healthy". Although free from disease such trees will have to be re-examined on the next round.

(2) a. Those on which *Fomes* mycelium is found growing on the exterior of one or more roots and (b) those plants of which the tap root or one or more of the exposed lateral roots are found to be actually diseased. These (b) plants must be removed and burned and, in fact, treated according to the procedure recommended in earlier paragraphs. In the case of (2) a. a single affected root may be amputated into healthy wood. The root removed and the cut stub tarred and the infection focus such as an old diseased root or stump eradicated.

Three rounds of inspection should be carried out at intervals of four months, followed by two rounds at intervals of six months, i.e. five rounds in all, covering a period of two years. By that time it is hoped that the fungus will have been almost completely eradicated.

It may be noted that there is no object in examining very small plants (later supplies) whose roots have not yet penetrated beyond the planting hole.

Unless a piece of infected material were introduced in the filling such plants could not yet have contracted the disease.

In the case of those plants (*a*) in which Fomes is present but no death of tissues has resulted it was for a time the practice to treat the affected root system with copper sulphate solution. This however has been found to be only a temporary palliative as the infection focus is still left and the tree soon becomes infected and eventually succumbs in practically every case. Early eradication is therefore the least expensive treatment and may save a neighbouring tree or trees whose roots have not yet penetrated the infected zone.

New Plantings

In the case of new plantings on jungle land it is found that there are usually one or two cases of Fomes occurring. This is due to natural presence of the parasite on jungle roots and stumps. Such cases when found should be treated as advised above and the patch demarcated and cleaned.

Length of Survival of Fomes on wood

In the case of wood decay a series of fungi usually operate one after the other. Some species such as *Fomes lignosus* require unrotted wood tissues for their needs, when this tissue is used up other organisms with different requirements take over the material and break it down further and so on, and the earlier organisms disappear. It will thus be seen that *Fomes lignosus* is able to survive whilst unrotted wood is present. That is on small roots etc. the infection is liable to disappear quickly, as these rot fast, and on large thick pieces to exist for as long as they take to rot. At the Rubber Research Institute living Fomes has been found on old stumps up to four years of age whilst it has disappeared quicker the smaller the piece. This emphasises the necessity for the removal of at least the larger pieces of rubber wood from the soil in infected patches and also the danger which is courted by leaving unexamined rubber stumps in the soil as in the case of poisoning old rubber and interplanting.

OIDIUM AND SULPHUR*

By

G. HUNTLEY

Panawatte Group, Yatiyantota

MEMORY, like prophecy, is notoriously unreliable, particularly the Eastern variety. 'There never was a S.W. like this'—until one's records repeat a worse !

And, so, in 1935, when I first introduced oidium to sulphur, there never was so green and rich a canopy for a victor save back in the dim days before Phytophthora and succeeding slumps, when rubber, in its transplanted infancy, remembered it was once a forest tree.

And since, has this oidium, which could never come down to the low country, (tea planters Sans Terai please note), proved a subject race ? Only in four of the intervening sixteen years has that pristine canopy been matched, nor, alas, was it due to sulphur. Once in every cycle of five years, 1935, 1940, 1945, 1950 have the fickle elements of wind and rain and weather aligned on Hevea's side. More often than not, in other seasons, have they joined forces with that

*The Rubber Research Board welcomes papers on subjects of general interest from outside contributors, but does not accept any responsibility for the views expressed therein.

great imponderable human frailty and, throughout almost two decades, encouraged and fostered an adaptive mould of cumulative resistance in its varying forms to sulphur, the only method of attack science has, to date, produced, so much so that today it is not merely a disease but a very definite menace, attacking not only the tiny leaf of earlier years, but every type at every stage.

One cannot help but ask, is sulphur any *longer* a remedy? Its particles are being made finer, its diluents cut down, carbon introduced in order to increase volatility, its application by aeroplane considered, and yet IS it the answer? Dr. Young has made a notable advance to our knowledge and discovered where the mould goes in the summer time advising a much increased dose, up to 100%, and treatment to commence at defoliation rather than budbreak; but enemies grow used to dawn attacks and there are no new weapons to fear.

Ah. but new cloaks for old, LCB. 870, with the hard cutin and the shorter cycle to maturity, the new panacea which like all other discoveries, false or true, become immediately universal in the rubber world. It would be a pity to "monoscionise" our rubber before it were determined at what point in the stem the invading gene of latex poverty first meets the tenant of plenty end if the ultimate "S" becomes a "D".

At the Kepitigalla spraying experiment I asked members of the I.C.I. if they could not isolate one of the dyes which has made such revolutionary advances in therapy in order to combat the mould. The answer came that it was possible but very expensive. Surely the defenders' increasing losses and growing danger of extinction are more so? Surely herein lies a *potential* solution.

Apart, however, from the avenue of a new remedy, and here I would ask Dr. Young if such, in its first application, has ever killed a pest outright or reduced it to impotency, is it not possible to harness nature as a *constant* ally?

The fifth year I mentioned earlier contained no magic other than, in each case, an almost rainless December promoting early winter, and an ultra dry January and February accelerated the cycle before the mould was called, viz.

	1 Avge. 1934-49 ins.	2 Avge. '35, '40, '45, '50 in ins.	Percentage 2—1
December ..	8.26	3.65	44
January ..	4.07	1.01	25
February ..	4.45	5.76	139
	<hr/> 16.78	<hr/> 10.40	<hr/> 62

1. aggravated by 14.98 inches in 1950 but from February 1st—16th no rain fell at all and refoliation was, by then, complete otherwise 2.69 or 60% for February and 44% in total of average.

Science cannot, as yet, create these conditions annually, but can we not discover a clone that not only possesses a high yield strain but will winter early and quickly? It would, I suppose, be impossible, (Would Dr. Young comment or confirm), to find or breed an evergreen Hevea, one that shed its leaves gently throughout the year.

LCB. 870 never wintered, in the strict sense of the word, until its first year of tapping, so I was told, or perhaps even later; to my own certain knowledge both PB. 86 and CHM. 2 have joined this category even up to the 3rd year of

productivity. It is significant that Dr. Young, in his illuminating article, R.R.S. Circular 1950, states, page 8.

"In only one case does there appear to be a different cuticle make up to that of the other clones (8) PB. 86—tougher and harder".

It would be very interesting to determine the cutin thickness of CHM. 2 : if similar peculiarities are found here then cutin becomes very definitely allied to either a favourable type of wintering or even no wintering at all. Will Dr. Young enlarge on this aspect in the case of deciduous trees ?

Herein lies my first postulant, can one develop cutin by breeding or the simpler process of special manure ingredients ?

Could plant isolation create an evergreen ? Can the deciduous become the non-deciduous, as in orchids the epiphyte has become the terrestrial, although the analogy is different ?

A long process of course, but, in the meantime, may not early wintering be induced by time and type of artificial (manure) culture ? Dr. C. H. Bunzl, formerly of Messrs. Baur & Co., Ltd., carried out, on my charge, some very interesting experiments on these lines many years ago, but war and short supply vitiated results.

One thing, however, we can do in this last direction, and that is to study the wintering of all accepted high yielders and develop the clone that, in all districts, possesses this characteristic. No intricate observation is required for, if winter be even, and thirteen days to commencement of defoliation for its completion and a further seventeen for the return of full new leaf.

If the winter is uneven percentage it.

In the fragmentary attempt that follows I have merely started the search and that only by the grace of three superintendents on places in which I am interested who, therefore, with me, have written the concluding summary.

Here it is and for accepted high yielding clones only.

JANUARY			FEBRUARY			MARCH			APRIL ONWARDS		
EARLY	MID	LATE	EARLY	YEAR	MID	LATE	EARLY	MID	LATE	APRIL	ONWARDS
TJ. 1			1945	PB86	GL1, BD5	BD5	TJ16	PBIG			
				TJ1	GL1, HC55	HC28		PR107			
					TJ1, WG6278	MK3/2					
WG6278	1946			GL1	HC55	TJ1					
				GL1	HC55	TJ1					
				PB86	MK3/2		HC28				
				PB86	PBIG						
				GL1	PR107						
					PR107						
					TJ1	TJ16					
					TJ16						
PB86			1947	GL1	TJ1		NOTE.				
no							GL1	TJ16 latest			
winter								HC55, WG6278			
								earliest			
GL1											
TJ1											
PB86											
PB86			1948	TJ1			NOTE.				
							(WG. 6278)	early			
PB86	GL1										
	GL1										
	TJ1										
	TJ1										
	TJ1										

Deep shade

Good shade

GL1 .. plain, are clones from 3
PB86 .. Kelani Valley Estates
(GL1) .. Clone in Kalutara District
(PB86) .. Clone in Galle District

SUMMARY OVER 7 YEARS

CLONE	NO.	YEARS REGD.	NO. OF SECONDS	YEARS REGD.
GL1	4	3	6	3
PB86	5	3	4	3
TJ1	4	3	5	5
HC55	—	—	4	2
WG6278	2	2	1	1
BD5	—	—	3	2
HC28	—	—	1	1

So far the conclusion is clear.

GL. 1, PB. 86 and TJ. 1 answer the required roll:

One must eliminate TJ. I because, except in a very dry year, it winters irregularly, and not merely tree by tree but branch by branch on the same tree.

PB. 86, beloved of hikers, phytophthora?

GL. 1—no inhibitions, S2, D3 equal to S2, D2 in yield—So what?

How often, in conclusion, does one hear this Research Institute of ours condemned by its students, but perhaps "student" is an incorrect term!

Might I add a plea that, having only an "area" in which to play it uses *our* playgrounds more and also *US*, for trials guided and controlled.

We planters live so much in offices today that we would welcome any higher command to leave soul-searing reiteration and explore.

OIDIUM AND SULPHUR — A COMMENTARY

In his article Mr. G. Huntley has asked several questions which are answered hereunder.

Appreciation of the attitude of such practical planters as Mr. Huntley for the help they give in elucidation of various problems by their observations and perennial interest is acknowledged.

Ref. Para. 3. *Oidium heveae* on *Hevea brasiliensis* was found in Ceylon in the low country in the Kalutara district before being observed at higher elevations. There appears to be no increase in virulence of the disease but rather a progressive increase in fungus population with time. The symptoms have not altered over the years but owing to the larger amount of infection the damage is greater.

Para. 4. Sulphur is still a good remedy, when obtainable, but with the increase in fungus population must be more carefully applied. It is no use waiting for oidium to appear before deciding to dust. If it appears it is probably too late to save the leaf. The early treatments under which control was established by sulphur dusting used the same quantity approximately of sulphur per pound as we now advise i.e. 10—12 lbs. per acre. During the depression years and on account of Phytophthora the dosage was reduced with resultant poor control of mildew.

Para. 5. A recent communication from Java informs us that the old records of the original crown buddings of LCB. 870 on seedling stocks have now been found. The results show that the yield of the tapping panel, crown budded with LCB. 870 was exactly the same as the non crown budded trees provided the bud union was about 150 cms. (58 ins.) above the tapping cut and possibly somewhat less. That is with crown budding at eight feet no yield depression whatever occurs.

Para. 6. Systemic fungicides have received intensive investigation for a number of years. The difficulty is to find an economically usable substance which will ward off the fungus and at the same time not harm the tree. One or two such substances have been developed but are too costly for commercial use. However, having found them the future in this direction is brighter but still distant. The real answer of course is natural resistance.

Paras. 7, 8, 9. It is improbable and probably impossible to breed an evergreen *Hevea brasiliensis*. This species is naturally deciduous and natural leaf fall is governed to a large extent by soil moisture conditions. If it is dry before normal wintering defoliation will occur somewhat early. If wet somewhat later. This is further complicated by local site factors such as drainage shallow soil etc.

Para. 10. Clone LCB. 870 partially wintered in some trees in the first year of tapping, in the second year wintering was normal. This is the usual thing in rubber with slight variations. The immature trees make more interseasonal growth and have a crop of younger leaves as well as older ones. At wintering the older ones fall the younger remain. The age at which complete wintering occurs also varies with site and competition factors.

Para. 11. The clone known as CHM. 2 has been definitely established as being clone LCB. 1320. There is thus now no such clone as CHM. 2. Clone LCB. 1320 has been investigated as to cuticle growth and is normal in this respect. See R.R.S. Quarterly Circular 1950.

Para. 12. We are endeavouring to breed a clone with the LCB. 870 type of cuticle by crossing LCB. 870 with high yielding clones. Some nine hundred seedlings are being studied in this respect. One has to have the character in

one parent and LCB. 870 is so far the only one available possessing it. Manurial practices in all crops, and it has been tried intensively with many, have failed to influence cuticle development. It appears that manurial treatment of any sort cannot speed up cuticle development unduly just as diet in man does not influence the date of development of a beard.

Para. 13. In orchids the terrestrial became the epiphyte not *vice versa*, likewise the rubber grew in South America and now in the East as well, this is merely an adaptation to environment. However there are very long odds against changing the essential genetic make up such as making an evergreen orchid deciduous or a deciduous rubber tree evergreen. Apples in the tropics are still deciduous though there is no need for them to be so as there is no cold winter.

Para 14. Phosphate manuring has been shown in some cases to accelerate refoliation. Nitrogenous manures applied prior to wintering delay wintering. These effects can be completely altered by seasonal differences such as soil moisture variations.

H. E. YOUNG
24.10.51

A STUDY OF YIELDS OF OLD BUDDED RUBBER AT THE RUBBER RESEARCH INSTITUTE

By

C. A. DE SILVA

Introduction

The question has been often put "How long will budded rubber last?" In other words how long will budded rubber continue to keep up its standard of economic yields reached during its best tapping years. Such a question also involves a close study of the onset of senescence, which can be postponed or hastened by the general treatment of the plantations from year to year with regard to tapping, manuring, prevention of disease and general cultural operations.

In the Nivitigalakele sub-station of the Rubber Research Institute are bud-grafts established from 1927—1932, which are of considerable value for the studying of the problems referred to under local conditions. The useful data obtained in the past with regard to growth and yield in the early years of test-tapping together with the commercial yields in more recent years are reviewed in this paper.

History of the 1926, 1927, 1928 clearings, Nivitigalakele.

The sub-station at Nivitigalakele was opened in 1926 for testing out the clonal progeny of high-yielding estate mother trees. Over six hundred of these were under observation for yield and other secondary characters.

Approximately sixty acres were opened on the contour for planting out one hundred and thirty Ceylon clones selected for testing. The soil in most parts was very poor consisting of a gravelly lateritic type with a hard pan of laterite a few feet below the surface. The clearings were regularly manured from 1929 and in more recent years these areas were given two to four pounds per tree of R400 mixture, recommended by the Institute. Sulphur dusting against Oidium was also regularly undertaken.

1926 Clearing, 12½ Acres

The area was planted in June 1926 with seedling stumps from Peradeniya ; budgrafting in the field was carried out from 1927 to 1929. Poor budding results were due to using transplanted seedling stumps as stocks. A large number of points were replaced with budded stumps in 1929—30.

1927 Clearing, 16½ Acres

This area was planted with basket seedling plants, which were budded in the field in 1928, 1929 and 1930. Planting points were supplied with budded stumps in 1930, 1931.

1928 Clearing, 31 Acres

This area was planted at three seeds per hole and partly with basket seedlings. Budgrafting in the field was carried out from 1930 to 1932. Supplying to a limited extent was done in subsequent years.

It will be noted that the clearings have budgrafts established from 1927 to 1932. It was the original intention to establish one hundred tree clones, but owing to poor stocks and lack of experience in budgrafting in these early days, the plots ranged from three to one hundred and twenty eight trees per plot, without any replications. The 1928 clearing had mostly twenty-five to thirty trees per plot.

Girth measurements were taken in 1937 and tables I, II and III give summaries of girth classes in relation to age with each clearing.

1926 Clearing — Table I

Date of bud- ding or sup- ply- ing	Less than 18"	GIRTH IN INCHES										Total No. trees	Age 1950
		18-21	21-24	24-27	27-30	30-33	33-36	36-39	39-42	More than 42"			
1927	14	19	30	39	57	31	21	13	3	1	228	23	
1928	6	7	29	27	38	24	13	2	—	—	146	22	
1929	97	102	147	152	165	60	16	2	—	—	741	21	
1930	49	8	4	1	—	1	—	—	—	—	63	20	
Total trees		166	136	210	219	260	116	50	17	3	1	1178	

1927 Clearing — Table II

Date of bud- ding or sup- ply- ing	Less than 18"	GIRTH IN INCHES, 1937									Total No. of trees	Age in Yrs. 1950
		18-21	21-24	24-27	27-30	30-33	33-36	36-39	39-42			
1928	..	20	27	72	51	53	49	16	6	1	295	22
1929	..	34	75	152	159	23	56	14	1	—	614	21
1930	..	136	158	153	62	14	2	1	—	—	526	20
1931	..	99	21	12	3	—	1	—	—	—	136	19
		289	281	389	275	190	108	31	7	1	1571	

1928 Clearing — Table III

Date of budding or supplying	GIRTH IN INCHES 1937								Total No. trees	Age in Yrs. 1950
	Less than 18"	18-21	21-24	24-27	27-30	30-33	33-36	36-39		
1930 . .	170	213	300	162	58 $\frac{1}{4}$	14	6		923	20
1931 . .	490	351	160	42	6				1049	19
1932 . .	502	33	9	2	—				546	18
1933 . .	59	1	—	—	—				60	17
1934 . .	22	—	—	—	—				22	16
1935 . .	13	—	—	—	—				13	15
	1256	598	469	206	64	14	6		2613	

From the foregoing tables it is evident that the major number of trees in 1950—51 range from eighteen to twenty three years of age. Test-tapping was commenced in October 1951, all trees being tapped with girth of sixteen or more inches at a height of three feet from the union. The first lot of trees was tapped in October and December, 1931 and was then rested till April 1932, when further trees were taken into tapping. Most clones were tapped on alternate day half spiral system. In later years a few were tapped on the double-four system.

At the present time trees of eighteen inches girth and over are tapped to get the necessary information on the performance of new clones as early as possible. It is interesting to note that the early tapping of trees with a girth of only sixteen inches has had no adverse effects on the performance of the mature tree. The present recommendations for commencement of commercial tapping are, however, restricted to trees of twenty inches girth and over. Many planters today prefer to wait until the required percentage of trees has reached a girth of twenty two inches.

Mature high yielding clones can also stand up to the double-four in later years, giving increased yields of over twenty per cent compared with the standard alternate day half spiral system of the same intensity (100%). Incidentally the former system is the cheaper of the two. The results obtained with double-four system, therefore, support the recommendations in Advisory Circular No. 17 on the feasibility of introducing the double-four tapping system in old budded rubber.

A summary of representative yields of the various clones for 1940 is given in Table IV and V. It should be noted that the yields are given on a basis of 130 and 65 tappings per tree on alternate day half spiral and double-four tapping systems respectively. The yields in general enable one to make a comparative study of the clones ; while the individual yields calculated on an empirical basis must be considered somewhat higher than those which can be expected from commercial plantations. About ten local clones, came in for serious consideration and of these only clones MK 3/2, WG. 6278 and HC. 28 are known at the present time.

The poor out turn of good clones from a somewhat extensive study of clone mother trees mostly over twenty years old can be attributed to the fact that it was not possible to find out whether the selected trees were early or late maturing at the time the yields were recorded. As can be expected most of the selected mother seedling trees apparently produced in their vegetative progeny characteristic for delayed high yields by exhibiting poor yields during the early years of tapping.

Except for the three clones now planted on a large scale and a few controls the whole of the sixty acres contains poor clone types. At the present time a considerable number of trees have been tapped for nineteen years in the 1926 and 1927 clearings, while in the 1928 area trees have been tapped from twelve to fifteen years.

The commercial yields from 1938 onwards for all three clearings are summarised in Table VI.

Some interesting facts about mature budded rubber emerge from this date.

Tapping on renewed bark which occurred about 1943 shows yields of 1000 lbs. and over for poorer and medium yielding budded rubber. This class of clone has also stood up to double three, 133 per cent intensity tapping, introduced in 1942, 1943, 1944 without adverse effects, especially with regard to brown bast. This may only be applicable to the more robust medium yielding types of clones. At Dartonfield clones PB. 25 and AV. 256 have yielded 1000 lbs. and over on double-three.

As the trees were marked for a ten year cycle on a bark consumption of six to seven inches per year, the introduction of double-three tapping with nine inches of bark consumption per year brings some of the trees in 1950—51 to tapping on second renewal. In 1945—46 six acres were cleared from the 1927 clearing and about fifteen acres from the 1928 area making thirty one acres for replanting in 1946. This reduction may partially account for poorer yields from 1946 onwards.

In general the results provide strong evidence that budded rubber with the correct treatment can produce economic yields on renewed bark. Growth measurements taken in June 1951, give the following average figures for the three clearings.

Clearing	Average girth in inches	Average bark thickness in mms.
	1951	
1926	39.46	7.97
1927	37.54	7.70
1928	38.61	8.28

The average figures for growth compare very favourably with old seedling rubber. Some of the best grown trees are well over fifty inches in girth.

The conditions of replanting laid down for the future call for a period of thirty to thirty five years of economic life for budded rubber, after which provision is made for replanting with better material. The trees at Nivitigalakele will provide most useful information in this regard in the next ten years.

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T. E. H. O'BRIEN—Notes on Growth of Budded Rubber Trees at Nivitigalakele, 3rd and 4th Combined Quarterly Circulars for 1927, Vol. 14, Parts 3 and 4.

C. F. FORD—Ceylon Clones IX 1940, 1st and 2nd Quarterly Circulars for 1941, Vol. 18, Parts I and 2.

TABLE IV
CLONES IN TEST TAPPING AT NIVITIGALAKELE

YIELD IN 1940 CALCULATED ON A BASIS OF 130 TAPPINGS
TAPPING SYSTEM S/2, d/2, 100%

Clone	No. of trees	Age in years	Mean girth in inches 1-1-40	Year of tapping	Mean yield per tree in lbs.
Field 3A — 120 tappings					
Wagga 6278	6	10	33.0	5th	17.1
Hillcroft 28	8	9½	36.8	"	13.7
Diyaberiyakande 1	9	10	28.8	"	9.7
Dalkeith 5315	6	10	31.8	"	8.4
Prang Besar 25	8	10	30.2	"	7.9
Prang Besar 23	8	9½	31.2	"	7.7
Dalkeith 1	10	10	32.0	"	7.6
Madolla 18	8	10	31.7	"	7.6
Seedling Control	10	12	35.4	"	7.1
Illabuluwa 37	10	10	30.7	"	7.0
Heneratgoda 24	9	10	27.7	"	6.7
St. George 40	10	10	31.7	"	6.3
Beau Sejour 3	9	10	32.6	"	6.0
Kiriella 11	6	10	33.8	"	4.6
Dalkeith 3513	6	10	29.2	3rd	6.4
Madolla 22	10	10	28.3	"	5.6
Hunasgiriya 1391	10	9½	23.5	"	4.7
Warriapolla 76	13	9	28.1	"	4.1
Nakiyadeniya 1	10	9	27.4	"	3.9
Markville 1	10	8½	29.2	"	3.7
Elston 2239/12	9	9	25.7	"	3.6
Nakiyadeniya 4	10	9½	26.7	"	2.9
Warriapolla 57	6	10	25.7	"	2.4
Warriapolla 24	10	10	25.4	"	1.
Pilmoor A. 44	10	10	22.8	2nd	5.0
Warriapolla 25	9	9	23.3	"	2.3
Field 3C — 123 tappings					
Millakande 3/2	10	10	38.4	7th	17.7
Millakande 1/1	10	10	28.3	5th	9.6
Field 4A — 131 tappings					
Prang Besar 186	23	8½	23.6	2nd	5.0
Seedling Control	24	12	33.5	2nd	4.7
Coodoogalla 45	21	8½	23.9	"	4.7
R. R. 8 (Marcot 52)	20	8½	23.3	"	4.6
Culloden 2	22	9	22.9	"	3.9
St. George 60	26	8	24.0	"	3.6
Kepitigalla 3	25	8½	23.0	"	3.0
Ambattenne 1	20	8½	23.2	"	2.9
Gikiyankande 1	24	8	23.7	"	2.9
Ambattenne 2	24	8½	23.7	"	2.7
Hapugastenne 33	23	9	22.9	"	2.7
Shaliacary 23	20	8	20.4	"	2.6
Gikiyankande 4	22	8	23.2	"	2.4
Millakande 1/2	27	9	22.2	"	2.3
St. George 2843	21	8	21.7	"	2.1
Warriapolla 22	14	8½	19.0	"	2.1
Gikiyankande 2	20	8	21.2	"	2.0
Clara 4	13	8	19.4	"	1.7
Alpitakande 18910	18	8½	20.7	"	1.6
Kepitigalla 7	9	9	19.3	"	1.0
Fields 4B and 4C — 131 tappings					
Millakande 1/3	6	9	32.0	5th	7.9
Bandarapola 8	9	9½	29.4	"	7.6
Bandarapola 21	9	9	29.7	"	7.3
Alpitakande 18775	8	9	27.9	"	7.1
Eriagastenne 1	10	9	29.0	"	4.1
Talgaskande 1/5	10	9	26.4	3rd	6.0
Humbaswalana 7/1	9	9	29.3	"	4.6
Millakande 13/2	10	8	27.1	"	4.3
Tempo 6	10	9	28.1	"	4.3
Alpitakande 843	10	9	24.6	"	3.7
Eriagastenne 2	10	9	25.8	"	3.0
Guava Hill 47	10	9	25.6	"	2.7
Guava Hill 50	10	9	25.6	"	2.1
Bandarapola 1	10	9	21.8	2nd	4.4
Troy 6/11	10	9	22.0	"	3.1

TABLE V

CLONES IN SEMI-COMMERCIAL TAPPING AT NIVITIGALAKELE
YIELDS IN 1940—41 CALCULATED ON A BASIS OF 65 TAPPINGS

TAPPING SYSTEM 2S/2, d/4, 100%

Clone	No. of trees tapped	Age in years	Yield per tree in lbs.
Mirishena 11	41	10—11½	8.7
Lavant 28	76	11—13	8.3
Govinna 1836	86	11—13	7.7**
Beau Sejour 5	23	10—11½	7.4
Cuileagh 4	105	11—13	7.4**
Eladuwa 1	156	10—11½	7.4
Millakande 10/2	87	10—11½	7.0
St. George 45	112	11—13	6.9
1926 Seedling Control	22	14	6.9
Cuileagh 5	95	11—13	6.9**
Mirishena 2	35	10—11½	6.7
Henaratgoda 2	95	11—13	6.6**
Glendon A: 4	84	10—11½	6.6
Palmgarden 3183	30	10—11½	6.6
Govinna 771*	81	11—13	6.5**
Millakande 1/1	28	10	6.3
Cuileagh 3	72	11—13	5.9
Kobowella 41	77	10—11½	5.9
Palmgarden 4849	87	10—11½	5.6
Kobowella 42	95	10—11½	5.4
Yogama 21Y	122	10—11½	5.3
Madola 110	48	10—11½	5.1
Mirishena 3	113	10—11½	5.1
Eladuwa 4	100	10—11½	5.1
Eladuwa 5	89	11—13	4.6
Lochnagar 1/15	81	11—13	4.6**
Yogama 8Y	51	10—11½	4.3
Frocester 56	75	10—11½	4.1
Talagalle 2	69	10—11½	4.1
Eladuwa 3	77	10—11½	3.9
Kosgalla 6	55	10	3.9
Yogama 1H	85	10—11½	3.7
Madola 15	29	10	3.6

* Tapped 2S/3, d/4, 67% on account of heavy incidence of brown bast.

** Yields of a few trees test tapped on S/2, d/2, 100% included.

TABLE VI
COMMERCIAL YIELDS IN NIVITIGALEKELE

	1926 Clearing			1927 Clearing			1928 Clearing			REMARKS		
	Crop in lbs.	Yield per acre	Acre-age	Crop in lbs.	Yield per acre	Acre-age	Crop in lbs.	Yield per acre	Acre-age	Crop in lbs.	Yield per acre	
1938	10 $\frac{1}{4}$	5491	511	13 $\frac{3}{4}$	6673	485	15	5730	383	1938—69% of the crop was derived from commercial tapping remainder from T.I.		
1939	12 $\frac{1}{4}$	6017	472	14 $\frac{1}{4}$	6876	466	19 $\frac{1}{4}$	7189	364	1939—76%	do.	
1940	12 $\frac{1}{2}$	7346	588	16 $\frac{1}{4}$	8753	539	31	9134	295	1940—76%	do.	
1941	12 $\frac{1}{2}$	5822	466	16 $\frac{1}{4}$	7282	448	31	10340	333	1941—72%	do.	
1942	12 $\frac{1}{2}$	9257	756	16	11006	688	29	14237	491	Tapping changed from Double 4 to Double 3 system. Payment according to results.		
1943	12 $\frac{1}{2}$	13949	1116	16 $\frac{1}{4}$	15623	961	31	20850	673	Double 3 tapping contd. (21 acres was slaughter tapped (1927—28)		
1944	12 $\frac{1}{2}$	14818	1185	16 $\frac{1}{4}$	18818	1158	31	21795	703	Double 3 tapping contd. (21 acres was slaughter tapped (1927—28)		
1945	12 $\frac{1}{2}$	12843	1027	16 $\frac{1}{4}$	18237	1122	31	19413	626	Double 3 tapping contd. do. do.	do.	
1946	12 $\frac{1}{2}$	9791	783	10 $\frac{1}{4}$	7375	720	16	7608	476	Changed over from double 3 to double 4 therefore drop in crop; 21 acres removed from commercial tapping.		
1947	13 $\frac{1}{4}$	12870	936	10 $\frac{1}{4}$	8442	785	15 $\frac{1}{4}$	10025	626	Double 4 tapping		
1948	13 $\frac{1}{4}$	13281	966	10 $\frac{1}{2}$	10157	967	15 $\frac{1}{4}$	12106	769	Change over from Double 4 to Double 3 without Sundays.		
1949	39 $\frac{1}{4}$	acres 1926, 1927, 1928.										
1950	12 $\frac{1}{2}$	10942	875	10	3049	804	15 $\frac{1}{4}$	11751	746	249 trees in 1927 clearing removed.		

Monkey Grubber and accessories with operative labour

PLATE I.



MECHANICAL FELLING OF RUBBER TREES

By

G. W. D. BARNET

WITH rising labour costs, alternative methods of clearing old rubber land for planting have become increasingly important. It was accordingly decided to use a slaughter tapped seedling area at Dartonfield for trial purposes in mechanical uprooting and a typical machine was obtained to that end.

The contrivance used was the "Trewella Monkey Grubber" an Australian production—which has been used successfully for many years in that and other countries for the uprooting of trees. These machines were used in Sumatra, for the clearing of old rubber areas in pre-war years.

The implement is of simple but strong construction (Plate 1), and consists of a two-gearied hand operated winch with steel hawsers, hooks, a grab and a pulley block.

The whole outfit costs Rs. 975/- and consists of a monkey winch, handle, drum, 50 feet of rope and attachments which weigh 2 cwt., 1 pull rope 40 feet in length weighing 62 lbs., 1 pull rope 15 feet in length weighing 33 lbs., 1 snatch block 30 lbs. and 1 grab 30 lbs., 1 pull rope $2\frac{3}{4}$ " in circumference and 80' in length weighing 116 lbs.

For operation, the winch is attached to the base of a tree or to a suitable rock by an anchor rope provided in the equipment. If extra purchase is required, the drum rope may be passed through a pulley, then around the tree and attached to the tail of the winch.

The hawser to be used is attached to the tree to be uprooted at a height of approximately 15 feet (a ladder is used for the purpose at Dartonfield) by simply hitching the steel rope around the tree trunk or branches with the aid of the special hook. The other end of this rope is attached either direct to the drum, cable or to the pulley block—whichever is being used in the assembly—by hooks and loops found on the ropes.

When it is found necessary to shorten the ropes, a simple and ingenious "grab" is provided. This grab makes it possible for the steel ropes to be attached at any desired length.

The ropes are then tightened by operating the hand lever of the winch in high gear and, when the load of the tree is taken, by changing to low gear. In a low gear a pull 24 tons can be exerted. Then the lever is worked back and forth until the tree falls.

No root cutting prior to felling is necessary even if the tree is wedged between large rocks.

From the same anchorage all trees within reach can be felled. The area thus covered is about $2\frac{1}{2}$ acres. Care should be taken, however, to see that a tree is left within reach from which the anchor tree can be uprooted in its turn.

In the Rubber Research Institute trial, it was found that four labourers were required to operate the machine on hilly land (plate 2). After sufficient practice these four men were able to uproot 24 trees in a working day. With the total wage of one labourer per diem at approximately Rs. 2/50, the cost of uprooting one tree is about -/42 cents. This compares very favourably with the rate paid by most contractors to their workmen for felling trees which, at present, is usually -/75 cents per tree for cutting the lateral roots and digging around the tap root until the tree falls.

An extremely important advantage of the mechanical method of uprooting trees over felling by hand labour or elephant is that the roots are not cut. The tree is pulled out with the tap root usually complete and with up to six feet of the large laterals attached to the tree (plate 3.). This has a distinct advantage from the root disease view-point since *Fomes lignosus*, if present, is liable to subsist on the large laterals and remain to infect the new planting. All tree stumps are readily accessible for Fomes inspection and treatment if necessary.

If a fairly big log or boulder is placed at the base of the tree to be felled so that the tree falls on it, the laterals on the lower side and the tap root are levered out when the tree falls to the ground.

This method has a great advantage, too, over that in which the tree is cut off near the ground and the stumps poisoned. Although the costs differ very little the added advantage of pulling out the stumps and large roots allow for a Fomes inspection and treatment.

When the stumps are left in the ground, Fomes cannot be detected in most cases and proves a source of expense and annoyance when it attacks the new planting. The method can therefore, be used to advantage in clearing operations even when the rubber wood is not saleable due to distance and inaccessibility.

In the case of trees poisoned and left standing, there is the risk of damage to at least some young plants caused by falling limbs etc. later. Also there is a risk of *Fomes lignosus* attack due to non-detection and not eradicating the source of infection.

Where the trees have been totally uprooted Fomes treatment can be given as required and there is no liability of damage to young plants.

With the mechanical tree puller, the trees can be felled in almost any direction desired. This is important near buildings, fences and overhead wires. Trees may also be felled along the contours for soil erosion prevention purposes when the timber is not saleable.

After felling operations have been completed and the trunks cut off from the stumps, there are usually, a few roots on the underside of the stump still attached to the ground. These stumps are pulled with the aid of the grubber until all the roots are cleared. Roots which break in this process can be grubbed out with mattocks—Fomes infected trees receiving special attention. The stumps thus freed can be either left to rot or stacked and burned if required. This stacking and burning can be omitted in stumps not affected by Fomes with a consequent saving in costs.

The burning of healthy stumps has an aesthetic appeal but is unnecessary unless the stumps are infected with disease. The rotting wood supplies nutrients to the young rubber plants. The cover crops should be pulled away from these stumps occasionally, however, for inspection as to whether they have been infected with *Fomes lignosus* later on from other sources. It may be necessary, to move any stumps which impede lining and holing, and also any works like cutting silt pits and drains or terracing.

With a little practice 4 labourers are able to free the roots of 32 stumps from the soil per diem. The cost of this work, therefore, is about -/31 cents per stump, and should be charged to grubbing, as it is really a part of this work.

Taking 72 trees per acre as the average stand per acre of old rubber to be uprooted one mechanical tree puller could deal with 50 acres in 150 days. Allowing for Sundays, holidays and very wet days about 6 months in all will be found to be a safe estimate of the time required to fell and clear 50 acres of old rubber trees with one machine.

PLATE 2.
Monkey Grubber in operation uprooting old rubber at Dartonfield



PLATE 3.

Uprooted rubber tree showing root system



Rubber Research Scheme (Ceylon)

MINUTES of the 105th meeting of the Rubber Research Board held at the Planters' Association Headquarters, Colombo at 2.30 p.m. on Wednesday, 7th February, 1951.

Present: Mr. F. H. Griffith, M.P. in the Chair ; Mr. Francis Amarasuriya ; Mr. L. S. Boys ; Major Montague Jayewickreme, M.P. ; Dr. A. W. R. Joachim ; Mr. F. A. Obeyesekera ; Mr. J. L. D. Peiris ; Senator C. Wijesinghe ; and Dr. E. Phillis (Director).

An apology for absence was received from Mr. W. J. A. Van Langenberg, Controller of Finance and Supply.

1. Minutes: Draft minutes of the meeting held on 18th December, 1950, which had been circulated to members, were confirmed and signed by the Chairman.

2. Director's Resignation: A letter from Dr. E. Phillis tendering his resignation from the post of Director was considered. The resignation was accepted and it was agreed that Dr. H. E. Young, Oidium Research Officer, should act as Director for a period of six months.

Dr. Young came into the meeting at this stage.

3. ANY OTHER BUSINESS :

Specified and blended bale rubber — It was noted that samples had been collected and sent to London for examination. The Scheme's newly appointed Chemist would work on them ; he would also bring out the equipment ordered in this connection.

Dartonfield,
Agalawatta.
23rd February, 1951.

Sgd. C. D. DE FONSEKA,
Secretary-Accountant.

RUBBER RESEARCH SCHEME (CEYLON)

MINUTES of the 106th meeting of the Rubber Research Board held at the Planters' Association Headquarters, Colombo at 2.30 p.m. on Tuesday, 20th March, 1951.

Present: Mr. F. H. Griffith, M.P. (in the Chair), Major Montague Jayewickreme, M.P. ; Dr. A. W. R. Joachim (Director of Agriculture) ; Mr. R. J. Hartley ; Mr. F. A. Obeyesekera ; Mr. J. L. D. Peiris ; Mr. R. H. Wickremasinghe (Controller of Establishments) ; Dr. H. E. Young (Acting Director, R.R.S.).

1. MINUTES :

Draft minutes of the meeting held on 7th February 1951, which had been circulated to members, were confirmed and signed by the Chairman.

2. BOARD :

(a) **Mr. Francis Amarasuriya**—had left Ceylon on 6th March and would be away until the end of June. The L.C.P.A. had not yet nominated a member to act for Mr. Amarasuriya.

(b) **Mr. R. H. Wickremasinghe**, C.C.S., Controller of Establishments had been deputed to represent the Minister of Finance in place of Mr. W. J. A. Van Langenberg with effect from 14th March, 1951.

(c) **Mr. F. R. Griffith**—The Chairman reported that he would be away from Ceylon from 6th April until 6th August, 1951. It was agreed that the Planters' Association of Ceylon be asked to nominate a member to act as its representative on the Board during the period of Mr. Griffith's absence from Ceylon and that Dr. H. E. Young, Acting Director, should officiate as Chairman of the Board during this period.

3. REPORTS AND ACCOUNTS :

(a) **Visiting Agent's Report**—was adopted and it was agreed that Mr. J. D. Farquharson should continue to function as the Scheme's Visiting Agent.

(b) **Visiting Engineer's Report**—was adopted.

(c) **Statement of Receipts and Payments for the 4th Quarter 1950**—was approved.

(d) **Estate Accounts from September to December 1950**—were tabled.

4. EXPERIMENTAL COMMITTEE :

The Experimental Committee was reconstituted to consist of only members of the Board.

5. STAFF :

(a) **Director**—It was reported that Dr. E. Phillis had left Ceylon having handed over charge of the Scheme's affairs to Dr. H. E. Young.

(b) **Chemist and Agronomist**—It was reported that Mr. Constable, Agronomist, and Dr. Risdon, Chemist, were due to arrive in Ceylon on the 16th and 25th April, respectively.

(c) **Estate Superintendent**—It was reported that Mr. G. W. D. Barnet had assumed duties as Estate Superintendent on 7th February.

(d) **Research Assistants**—The principle of sending suitable Research Assistants abroad for training after the completion of their period of probation was accepted.

(e) **Bungalows and Club House**—Approval was given for the construction of two bungalows for Research Assistants and a Club House at Dartonfield.

6. LEASE OF NIVITIGALAKELE EXPERIMENT STATION TO THE TEA RESEARCH INSTITUTE :

In view of certain facts recently made available to the Board it was agreed that Nivitigalakele Experiment Station should not be leased to the Tea Research Institute. The Acting Director was asked to withdraw the application for transfer.

7. CREPE BLEACHING :

It was reported that the R.R.I. Malaya had agreed to allow the process patented by them for the bleaching of crepe rubber by the use of R.P.A. 3 emulsion to be used by producers in Ceylon subject to approval by the Scheme. Producers had been informed through the P.A. of Ceylon and certain importers were making arrangements to import the necessary chemicals.

Dartonfield,
Agalawatta.
19th April, 1951.

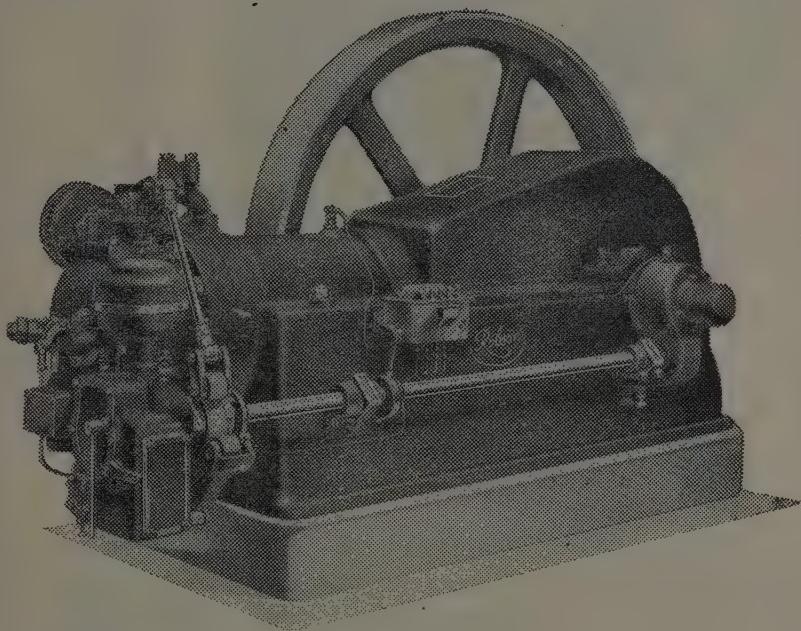
Sgd. C. D. DE FONSEKA,
Secretary—Accountant.

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Scientific Officer "

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" As at 31st March 1951.

* Seconded to Rubber Research Institute of Malaya.

